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ABSTRACT

This study examined how support tools (i.e., prompts that support students to use self-explanation and self-monitoring strategies) facilitate convergent knowledge building processes in a World Wide Web-based virtual university engineering course. A quasi-experimental study was designed. An engineering class of a virtual university was selected as the research site, and the students in the class were randomly assigned to two different work environments: without support tools, and with support tools. It was found that students' frequent interaction with their peers is not enough either for students to integrate knowledge or to develop/improve coordination of group work in an online learning environment. The type of interaction matters, especially because convergent types of interaction facilitate students' knowledge integration. (Contains 14 references.) (MES)

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# Design of support tools and knowledge building in a virtual university course: Effect of reflection and self-explanation prompts

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**Abstract**: In a WWW-based virtual learning environment where students and teacher are physically separated, the quantity and quality of interaction among students or with instructors have effects on learning. Lack of constructive activity is often identified as one of the major causes for poor learning. We developed support tools (prompts which support students to use self-explanation and self-monitoring strategies) and studied how support tools facilitate convergent knowledge building processes in a WWW-based virtual university engineering course.

For the study, a quasi-experimental study was designed. An engineering class of a virtual university was selected as the research site and the students in the class were randomly assigned to 2 different work environments: 1) without support tools, and 2) with support tools.

This study has an implication for theory that the opportunity to engage in interaction itself is not enough for students to integrate knowledge or develop/ improve the coordination of group work in an online learning environment. Students' frequent interaction with their peers is not enough either for students to integrate knowledge or develop/ improve coordination of group work in an online learning environment. The type of interaction matters, especially because convergent type of interaction facilitates students' knowledge integration.

## 1. Introduction

In a WWW-based virtual learning environment where students and teacher are physically separated, the frequency of online interactions among students or with instructors may have an effect on learning. One positive effect is that these interactions may facilitate knowledge building activities in virtual courses. However, negative effects, like lack of interactions, may surface. The lack of such an interaction may be one of the major causes of unsatisfactory learning experiences. However, problems may arise even when interactions between students in distance learning occur. The types and the quality of interactions matter. Many students in a virtual university simply tend to post their ideas or read others' ideas without engaging in deep thinking processes such as analyzing, evaluating, and synthesizing ideas. Furthermore, students often merely browse the WWW superficially and do not engage in thoughtful and active learning (Ritchie & Hoffman, 1997). If students rarely engage in convergent knowledge building in a virtual university environment, the knowledge building process is not complete, and students are not able to construct new understanding or build new concepts.

This lack of knowledge linking and structuring activities in the online learning environment was identified as a problem in the networked learning environment by previous studies (Chung, 1999; Harasim, 1990; Harasim, Calvert, & Groeneboer, 1997; Hewitt, 1997) and can have a negative effect on both the students' efforts to synthesize ideas and group collaborative processes (Hewitt, 1997). This study proposed to develop support tools to

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foster learning in such an environment and investigated the characteristics of interactions with the aid of the support tools in a WWW-based virtual learning environment.

The purpose of this research was to study how support tools facilitate knowledge building processes in a WWW-based virtual university engineering course. Specifically, the first objective was to examine whether students engage in different types of knowledge building activities in when they use support tools. The second objective was to assess the effect of support tool use on student performance.

The research result indicates that students did not engage in different types of knowledge building activities when they used support tools. However, the research findings confirmed that the use of support tools enhanced student performance in integrating concepts in group report writing. This study has an implication for theory that the opportunity to engage in interaction itself is not enough for students to integrate knowledge or develop/ improve the coordination of group work in an online learning environment. This study's implication for the design of a virtual learning environment is that support tools be designed to promote student convergent knowledge building and higher knowledge integration.

## 2. Knowledge building Processes

This research views learning as a knowledge building process through the mediation of social interaction, tool use, and reflection. Knowledge building is similar to knowledge integration (Linn & Elyon, 1996 cited by Davis, 1998) which refers to the process of expanding a repertoire of ideas, discriminating between ideas, and reorganizing the links among them. Exploration and construction represent divergent and convergent aspects, respectively, of knowledge building. On one hand, divergent knowledge building entails exploring and sharing of diverse ideas which can lead to convergent knowledge building. On the other hand, convergent knowledge building involves linking ideas (Harasim, 1990), constructing explanations (Chan, Burtis, & Bereiter, 1997), making connections among different ideas, and bringing ideas together (Hewitt, 1997). In classroom or group discussion situations, students' exposure to many different ideas does not automatically lead them to new levels of understanding, construction of new concepts, or problem solving. Students learn new concepts or reach new understanding only if they engage in both divergent and convergent knowledge building activities. These knowledge building activities are facilitated by using self-explanation and self-monitoring strategies (Palincsar & Brown, 1984).

Learning process is dynamic, recursive, and iterative (Chung, 1996). Students constantly define problems or the purposes of their learning, explore different information and ideas, evaluate their relevance, and accept or reject ideas to be used for one's purpose. During this dynamic process of learning, students' capabilities to plan and monitor their whole learning processes are crucial. A learner's mental activity to plan and control one's learning processes is called reflection, which is a trait of experts (Ertmer & Newby , 1996). Students who received explicit instruction about planning/monitoring and self-explanation strategies (Bielaczyc, Pirolli, & Brown, 1995) develop a higher understanding than those who received implicit instruction do.

Webb, Tropper, and Fall, (1995) found that the number of occasions nor the amount of time students spent on interacting with classmates were not related to learning. What showed to be important was that, after receiving help, students would engage in constructive activity. Students who actually verbalized the work or tried to understand the explanation after receiving the help did learn more than those who did not do those things. Students' engagement in highly constructive activities (i.e., reworks or explains problems) after receiving help was strongly correlated to student achievement. Students who worked at the lower levels of constructive activities such as doing nothing or copying other's work were not very successful in solving new problems. They concluded that in order for students to actively engage in constructive activities, it was important to encourage individual students to seek explanations that they understand and to continuously work on a task until they could work on their own. The authors emphasized the importance of designing instructional interventions such as self- explanation prompts, which support constructive activity and suggest that students study the nature of explanations, which encourage constructive activities.

### 2.1 Knowledge Building in a Virtual Learning Environment

In virtual learning environment, the same problem emerged in recent studies on student interactions. Researchers pointed out that the lack of convergent interaction as a problem in a virtual learning environment (Chung, 1999; Harasim, 1990; Hewitt, 1997, Scardamlia & Bereiter, 1991). Often students merely browse WWW superficially and do not engage in thoughtful and active learning (Richtie & Hoffman, 1997). Students engage

readily in divergent processes of knowledge building but needs help in the convergent processes (Chung, 1999; Harasim, 1990; Scardamlia & Bereiter, 1991).

To promote the facilitation of convergent knowledge building processes in a networked learning environment, researchers suggested the following approaches: developing support tools, such as concept maps (Harasim, 1990; Harasim et al., 1997); using linear message systems while rejecting threaded message systems; and developing a networked structured message which can provide easy access to other students' displays of ideas and their relationships (Hewitt, 1997). These approaches would be helpful in developing a system which students would find easy to use in building their knowledge. However, those tool development approaches would not be able to help students to be conscious about their learning processes and to monitor their knowledge building processes. In addition, those approaches would not be able to support students to learn to seek for explanations, which they can understand or to learn to continuously work until they can figure out the problems.

Another approach, which would facilitate seeking explanations and monitoring learning processes is designing the explanation prompts as suggested by Webb et al. (1995). I developed support tools, which would extend the use of prompts not only for explanation but also summarization and planning/monitoring to facilitate active learning in a virtual learning environment.

## 3. Support Tools

I developed prompts to support three activities, namely, summarizing, explaining, and reflecting. I selected them because these three activities would activate individual background knowledge. For instance, self-directed summarizing helps in knowledge construction by enhancing student comprehension of the lecture and at the same time by having them check their own comprehension (Palincsar & Brown, 1984). Self-explanation and self-regulation activities foster knowledge construction and problem solving performances (Bielaczyc et al., 1995). Finally, reflective activities include monitoring comprehension and learning activities, and clarifying and addressing failures in comprehension.

In asking students to summarize the lecture specifically, I had them identify the main ideas and elaborate their relations to one another. This procedure is related to exploring for new information and identifying the main ideas of the knowledge building process mentioned earlier. Then, in asking students to explain concepts using concrete examples and to connect these concepts to main ideas, I asked them to interpret the lecture, and to analyze and critically evaluate the ideas in the lecture. This process is related to analyzing and evaluating the relevance of knowledge building. Finally, reflective activities asked students to plan and monitor their own comprehension of the lecture and learning activities. This procedure is related to identifying the purpose and planning and monitoring of the knowledge building process.

## 4. Experimental Study

The purpose of this research was to study how support tools facilitate knowledge building processes in a WWW-based virtual university engineering course. Specifically, the first objective was to examine whether students engage in different types of knowledge building activities in when they use support tools. The second objective was to assess the effect of support tool use on student performance.

For the study, a quasi-experimental study was designed. An undergraduate engineering class of a virtual university was selected as the research site and students were randomly assigned two different environments: 1) without support tools, and 2) with support tools.

Research Questions

1. How do students using the tool to support their learning in an electronic learning environment differ in the knowledge building processes?
   - Hypothesis . 1.a: Students will show different participation frequencies in online group discussion between students with the support tool and those without .
   - Hypothesis . 1.b: Students in the treatment condition with the support tool will engage more in convergent interaction than students in the control group without the support tool during online group discussion.
2. How does the tool supporting learning in an electronic learning environment promote knowledge building?
   - Hypothesis . 2.a: Students using tools to support their learning in an electronic learning environment build more integrated knowledge (number of cited principles, examples, evidences and

other sources).

### 4.1 Setting

An undergraduate engineering course on "Introduction to the Internet", for Fall 1998 at a big Midwestern Virtual University was selected as the research site. Students learned about broad aspects of the Internet such as the History of the Internet, Internet tools, Design of Web pages, and other technical topics. I created a group activity and the instruction for the two week period of the "Design of Web pages" unit. In the unit, the students' tasks were as a group to discuss and write the strengths and weaknesses of two different university homepages and to write recommendations on how to improve one university homepage. A group leader was assigned as a moderator to coordinate and facilitate the group work. There were online support of TAs and instructor whenever students encountered technical problems. Electronic shared work space was supported by program called "Web-talk". The Web-talk is a group online discussion tool, developed by the virtual university, in order for students to work together by planning and discussing their work online.

### 4.2 Data Collection and analysis

The participants were college students who were enrolled in the virtual course 'EGRXXX' in Engineering. For the treatment group, We developed cognitive support tools which prompt students to use the learning strategies such as planning/monitoring, summarization, and explanation in the virtual class. For the control group, no cognitive support tools were provided.

#### *Data collection*

Four kinds of data were collected in this study: pre-survey responses online, archived communication data online, group project data online, and post-survey responses online. The student responses to both pre-survey and post-survey were submitted through web, and the data were collected online. The online pre-survey was administered in the beginning of the semester and the online post-survey was administered after the lecture unit, "Design Workshop". The online survey data were later coded to SPSS. The communication data among students in the online class and the group project data for the "Design Workshop" were automatically archived in the Web-talk (a group communication tool developed for the virtual university), and the archives on the Web-talk were used as my data. Student interaction data and the group project data were taken from the archives of the Web-talk.

#### *Coding*

**Interaction patterns** examine the pattern of online participation among students. We used the 3 distinct features of knowledge building; reflection, divergent knowledge building, and convergent knowledge building. The pattern of participation, thus, was coded into three kinds: planning and monitoring, divergent knowledge building processes such as self-introduction such as idea sharing, and convergent knowledge building processes such as agreeing or disagreeing between different ideas, synthesizing ideas in writing.
**Performance** was measured by the quality of the student's two reports (comparison of the two university web pages and a recommendation). The reports submitted as the product of the group project were analyzed and scored to measure how much different ideas and concepts from the lecture were integrated in the recommendation letter.

#### *Data Analysis*

To answer the research question 1, descriptive statistics was used to compare the frequency and patterns of discussion participation between the 2 groups. One tail T-tests was conducted between the two groups with alpha level at 0.05. For the research question 2, one tail t-test was conducted with alpha level at 0.05.

## 5. Results

**Research Hypothesis 1.a ( about Participation Frequency)**

There was no significant difference between the control group and the treatment group in participation frequencies. Students in the treatment group did not participate more frequently than that of the control group. In the categories of idea sharing and individual writing, the control group posted more messages, even though the difference is not big enough to be significant. In the categories of planning and convergent interaction, the treatment students posted almost twice as many messages as the control group.

**Research Hypothesis 1.b (about Convergent interaction)**

The difference between participation level in convergent interaction between the treatment and control group, was not statistically significant ($p<0.05$). Students in the treatment condition used a statistically significantly (alpha=0.1) higher number of shared concepts during their group interactions. The researcher interpreted this result to mean that in the treatment condition certain themes emerged from online group discussion and students were more engaged in their knowledge building than in the control group.

**Research Hypothesis 2.a (about integration of knowledge)**

There was significant difference between the treatment and control group in the level of integration of concepts represented in the group reports. The treatment group integrated more concepts, examples, and evidences in their project writing than the control group. There was a significant difference between the treatment and control groups in the levels of integration and elaboration of concepts in the group reports ($p<0.05$). The treatment group used more concepts, examples, and new ideas in their project writing than the control group.

This result supports my hypothesis that students who use the support tools which prompt them to summarize the lecture, explain the concepts, and reflect on what they need to know and what they need to plan to do the group tasks, would build more integrated knowledge than students in the control group, who did not receive any prompts.

## 6. Conclusion

This study conclude that the support tool use as well as group interaction enhances their engagement in knowledge building, especially knowledge integration such as their report writing in the online virtual university learning environment.

This study finding suggests that the high frequency of group interaction itself is not enough to promote student knowledge building, such as coordinating their group work and bringing different ideas together. While the interaction frequencies of students in both treatment and control groups were almost same, students in the control group, who engaged in group interaction, only reported their divergent knowledge building experience. Moreover, compared to the treatment group, less integration of knowledge occurred in the control group. In other words, students in the treatment group, who had the opportunity to engage in group interaction, as well as using summarization, self-explanation, and planning/monitoring prompts, engaged in more convergent knowledge building experiences and integrated more concepts and examples than student in the control group.

From the study, we can recommend to design support tools to promote student convergent knowledge building and higher knowledge integration in a virtual learning environment. This study finding indicated that the group of students who used the support tools of summarization, self-explanation, and planning/monitoring experienced convergent knowledge building and integrated knowledge more than the group of students who did not use the support tools.

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